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Concept of Value Engineering in Construction Industry

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Abstract: ***Nowadays, Value engineering (V.E.) is considered as a tool of construction management that can help companies to improve their procedures, services and final products regarding the client's needs, as an end user, with respect to time, cos t and quality. The V.E. process has evolved from previous methods based on the concept of value and functional approach. These methods were pioneered by Lawrence D. Miles, in the 1940's and 50's, who developed the technique of Value Analysis (V.A.) as a method to improve value in existing products. The concept of V.E. / Value Engineering (V.E.) has been developed through the years and numerous standards and manuals have been created.The wider construction market (U.S.A., U.K., etc.) has identified V.E. value and has used the practice extensively. The present study aims to clarify the concept of value management in construction industry, via literature review, and references and books the use of V.E. in global level and to present a short description of the worldwide know-how. That will be achieved by a historical review of V.E. and by the illustration of the most common definitions and a thorough terminology review. In addition, we will present three different markets applying V.E. worldwide, the U.S.A., the E.U. and the Japan Standards for V.E.***

Keywords: Value engineering, Function analysis, Value management, labour theory value, value planning

1. Introduction

Value engineering (VE) is a structured and analytical process that seeks to achieve value for money by providing all necessary functions at the lowest cost consistent with required levels of quality and performance (AS/NZS, 1994). VE, which has been widely used in many developed countries for several decades, is a useful tool that can help the industry to meet these challenges .

On one hand, the major reasons for choosing VE, according [1], are to achieve cost saving, establish a clear project objective and provide creative thinking for design improvement. This target cannot be met unless there is a clear cut picture of actual situation of the projects in terms of time; cost and quality which are crucial cause of concern in Value engineering process also, so that in order to assess the process of value engineering, it is necessary to implement the feedback system during execution of the project.

On the other hand, as a matter of fact, construction projects are subjected to changes so that there is a requirement of this issue to have the updated feedback throughout the whole process of construction project. Timely and targeted feedback can able the project management to identify problems early and make adjustment that can keep the project on time and budget. Earned Value engineering (EVE) has proven itself to be one of the most effective performance measurement and feedback tools for managing projects which is in close relation with the concerns of value

Value engineering (VE) is a structured and analytical process that seeks to achieve value for money by providing all necessary functions at the lowest cost consistent with required levels of quality and performance (AS/NZS, 1994). VM, which has been widely used in many developed countries for several decades, is a useful tool that can help the industry to meet these challenges. However, reluctance to use VM often stems from the time that an expensive team has to be employed to undertake the VE process (Shen and Chung, 2002). It would therefore be helpful to find a way that can make the process more efficient and effective to make the cost of undertaking VE decrease .

VE has been used to improve the value of projects in government, the private sector, and the manufacturing and construction industries, and value concepts have spread worldwide. Concurrent with this growth, a number of other value improving tools, techniques, and processes emerged, many of which were complementary to and were integrated with the value concepts (SAVE International, 2007).

The first use of VE in the construction industry occurred in the Navy Facilities Engineering Command in the USA in 1963 (Dell „Isola, 1982). The application of this technique in the construction industry expanded quickly as it became a mandatory requirement in many public projects in USA. In particular, the required inclusion of VE in the work scope of construction management services further drove the application of VE in this industry. After VE entered the construction industry, approaches have been developed by the combined effort of academic research and practitioners in order to fit the unique characteristics of the industry

According to Kelly [2], in a comprehensive review of briefing studies for construction, the major weaknesses of the current briefing guides were too general and implicit to offer real assistance to clients and designers. These guides show what should be done without explaining how things can be done. They concluded by suggesting the use of Value engineering (VE) for the future development of the briefing guide.

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Internationally, VE has been recognized as an emerging paradigm that focuses on continuously increasing the value provided to the client and is widely accepted as an important tool in recent management of construction projects. The construction industry is an important field for VE at the international level VE is also critical to the success of projects as it provides a basis for improving value for money in construction. It also focuses on value rather than cost and seeks to achieve an optimal balance between time, cost and quality as it provides a method of integration in the building process that no other management structure in construction can provide. Hence, the functional requirements and seeks overall optimization were explored accordingly (Shen 1995). This was later endorsed by Liu (2003) who emphasizes the importance of VE practice to the construction industry, as it has proven to provide significant benefits to clients if it is used correctly.

Value Engineering (VE) is connected originally with Value Analysis aimed at obtaining the necessary functionality level at the lowest cost without compromising the quality, reliability, and without deterioration of service and delivery (Crum, 1973). It is a systematic method to improve the "value" of goods and services by using an examination of function what affects the cost amount. In literature there are numbers of definition given by the different expertise and practitioners of VE technique: Miles [3] defined Value Engineering as a discipline action system, attuned to one specific need: accomplishing the functions that the customer needs and wants at the lowest cost. Zimmerman (1982) said about Value Engineering that it is a proven management technique using a systematized approach to seek out the best functional balance between the cost, reliability and performance of a product or project. Connaught on and Green (1996) defined VE as a systematic approach to delivering the required functions at lowest cost without detriment to quality, performance and reliability. Creativity and proactive team approach within VE projects was underlined [4]. Value engineering as a project at the lowest cost that consists of efficient identification and the elimination of unnecessary cost without detriment to: safety, quality, reliability, performance and delivery was identified by standing (2001). Development of the Value Engineering concept is associated with General Electric Company, USA. This method was invented by Electrical Engineer Lawrence. D. Miles within General Electric Company, who noticed that many of the substitutes were providing equal or better performance at lower cost and from this evolved the first definition of Value Engineering. The General Electric Company is generally credited with developing the technique, then known as "Value Analysis [5]." In 1954, the U.S. Navy's Bureau of Ships applied the concept, which it called "Value engineering," to reduce costs during the design stage. The Department of Defense (DOD) accepted VE as a sensible means of obtaining the best practical value from its procurements and, in 1961, adopted VE in contract clauses under the Armed Forces Procurement Regulations (AFPR), permitting contractor incentives in sharing VE contract cost reductions.

There are some features of VE that are crucial for its success such as:

1) Using many widely accepted analysis concepts and techniques
2) systematic process following job plan
3) focusing on identifying and analyzing the function the project component(s) or activity fulfils
4) Using creative analysis techniques
5) Performed by a team not associated in any way with the design team and draws upon the individual and collective viewpoints, experience, and knowledge of its members
6) providing the needed functions safely, reliably, efficiently, and at the lowest overall cost
7) Improving the value and quality of the project and reducing the time to complete the project.

1.2 Research Objectives

- To study value engineering methodology in the construction industry
- To Identify the areas of value engineering in construction industry
- To Identifying the importance and benefits of application of value engineering techniques

2. Historical review of value and V.E.

Karl Marx's 1865 lectures also offer a first definition for value and especially for a commodity, obviously in a standard of his days (it is considered by the modern economists out-of-date by the theory of marginal utility). Marx distinguishes value between several key uses of the term value so that for any commodity [6]:

1) Value "in use" is the usefulness of this commodity, its utility;
2) Value "in exchange" is the relative proportion with which this commodity exchanges for another commodity (in other words, its price in the case of money);
3) Value without any qualifying adjective refers to the amount of labor embodied in commodity

2.1 U.S.A (save international) – value methodology standard

- Value study team is the key to the successful application of value study. Although the methodology is important, it has been proved that a good study team can bring the best value
- The team leader plays important role to the success and must have thorough training. The members of the team must also have a good training, both in the V.M. and the projects in general. These include cost, estimating, procurement, design, construction etc. [7].

2.2 The Value Methodology Job Plan.

"The Job Plan outlines specific steps to effectively analyse a product or service in order to develop the maximum number of alternatives to achieve the products or service's required functions" (SAVE, 1998). A systematic Job Plan used by the V.E. is illustrated in Table 2.2.1. The main part of the job plan is the Value Study stage.

This stage includes six steps:

1) Information Phase: Gathering of information to better understand the project.
2) Function Analysis Phase: Analyzing the project to understand and clarify the required functions.
3) Creative Phase: Generating ideas on all the possible ways to accomplish the required functions.
4) Evaluation phase: Synthesizing ideas and concepts to select feasible ideas for development into specific value improvement.
5) Development Phase: Selecting and preparing the "best" alternative(s) for improving value.
6) Presentation Phase: Presenting the value recommendation to the project stakeholders.

The V.E. Job Plan consists of three main categories: 1) Pre-study, 2) Value study, 3) Post-study. All phases and steps are successively executed. However, the team is possible to return in a previous phase or step within a phase on a repetitive basis.

Table 2.2.1 Value engineering JOB plan

Pre-Study	*Value Study*	*Post-Study*
Collect User/Customer Attitudes	Information Phase Complete Data Package Modify Scope Function Analysis Phase	Complete Changes
Complete Data File	Identify Functions Classify Functions Develop Function Models	Implement Changes
Determine Evaluation Factors	Establish Function Worth Cost Functions Establish Value Index Select Functions for Study	Monitor Status
Scope the Study	Creative Phase Create Quantity of Ideas by	
Build Data Models	Function Evaluation Phase Rank and Rate Alternative	
Determine Team Composition	Ideas Select Ideas for Development Development Phase Conduct Benefit Analysis Complete Technical Data Package Create Implementation Plan Prepare Final Proposals Presentation Phase Present Oral Report Prepare Written Report Obtain Commitments for Implementation	

3. Role and application of V.E in construction industry

3.1 V.E. in general

Value in V.E. can be expressed as the operation presented below, expressing that value correlates to "what we get or want" and "what we pay" for a project. The V.E. study has to optimize the ratio of required functions over the whole life cost. In other words value is the satisfaction of needs over the resources used.

$$\text{Value} = \frac{\textit{What you get (or want)}}{\textit{What you pay}}$$

By the above ratio it is easily pointed out that the improvement of value depends on the reduction of the denominator or the increase of the numerator.

3.2 V.E. process description / How does V.E. work

Initially, the Project Manager and the potential client are having a first briefing by the V.E. Facilitator to discuss if a V.E study is needed and how it can be applied to support the potential project. If there is an agreement, a first planning meeting takes place. This meeting aims to set the objectives for the study and to identify the constraints. Moreover, the workshop team members and the timetable for the study are agreed.

The initial bullet points of the meeting between the stakeholders are:

- The needs for the project
- The scope
- The deliverables
- The key functions and risks.

At this stage, the first opportunities for innovation are examined and the basic means of implementation are developed according the economics, considering the required factors, time and quality. In order to produce successful and equitable conclusions and actions, the above mentioned team must consist of stakeholders with the right balance of knowledge, skills, experience and judgment. This is one of the best ways to reconcile differences in view between stakeholders.

3.3 Benefits of V.E

a) Simplification of methods and procedures resulting in less recurrent costs and a more efficient process
   - Savings in time cost and energy
   - Expedited decision making
   - Risks can be better forecasted and understood by all
   - Resources and time wastage can be minimized
   - Savings can be redirected to add value
   - Programmers can be staged or phased, allowing progress

b) Better communication and understanding of the project"s objectives
   - Appropriate quality
   - Responsiveness to client"s priorities

c) An opportunity for the client to formally participate in the design process
   - Client insight into the project

d) Improved communication between the parties

4. Results & Analysis

The literature and books and references agreed that the value engineering can be managed although this is difficult. The

majority felt that a project management team is best equipped to manage this process, although this was not unanimous and with a larger sample the literature and books and references may have been different. This result reflects the literature review. Authors held a wide range of different views. The use of the books and the internet and literature can be defended equally as well as the use of a Previous studies. All agreed that decisions made in a project's early stages have the greatest effect on the final cost quality and time management.

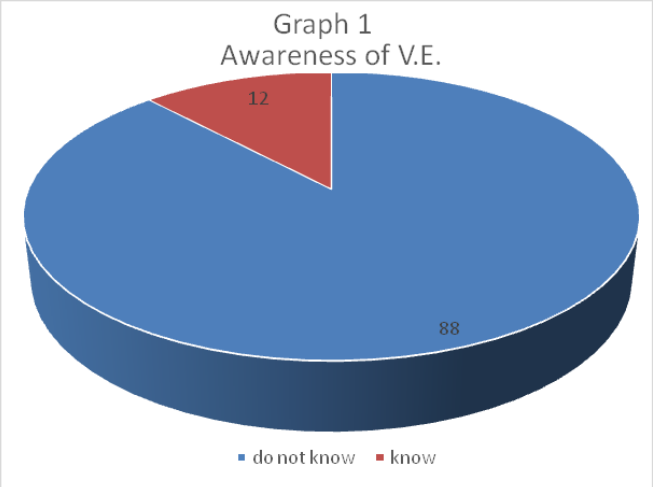
They acknowledged that least money is spent on this stage as a proportion of the total project budget. All agreed that VE is an effective construction industry management tool that can help to bridge the gap between design and construction. There was a difference of opinion concerning when VE can offer the greatest rewards, although all did agree that the least benefits would come from its application in the occupancy stage

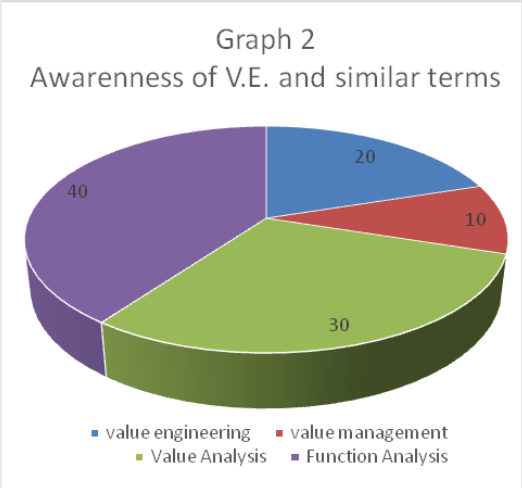
A number of benefits, resulting from the use of VE, were stated by the sources. These benefits centered on reducing unnecessary costs, improving constructability and increasing performance, quality and value. Other perceived benefits included improved decision making as result of better team morale and focusing on the design all felt that VE is not simply a cost cutting exercise

The books and references considered the main barriers to the implementation of VE to be the adversarial and fragmented nature of the industry, ignorance, its cost and a lack off or ward planning. This result parallels the findings of the literature review. However what is noticeable is that the culture of the industry and lack of education regarding VE are thought by the references to be more important than a lack of senior management support. Recommendations were given as to how the barriers to the implementation of VE may be overcome. The most common responses were to include it as a mandatory service as part of a consultant's terms of engagement, emphasize front end planning of projects to ensure time is made available, to educate clients as to its techniques and benefits and a change in industry culture to promote a cohesive not confrontational working environment.

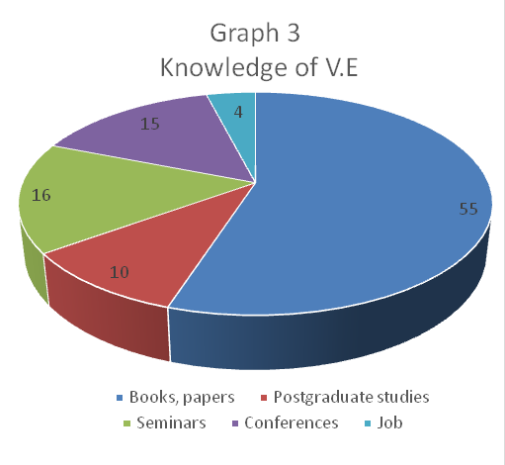
4.1 Awareness of V.E

As far as the construction enterprises‟ awareness of V.E. is concerned it arises that most of them have heard of the term V.E. or other similar terms such V.M., V.A., F.A., Job Plan (J.P.). In specific, 88% of the respondents are familiar with the term V.E. as opposed to 12% who have never heard of the term VE. or other similar terms (Graph 1).





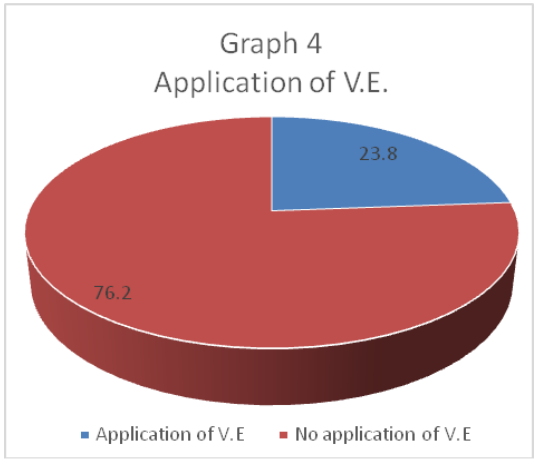
The respondent experts, who answered positively in the question if they recognize V.E. and other similar terms, clarified that they are familiar with the terms mainly from scientific papers and books, secondly from postgraduate studies thirdly from seminars, conferences and scientific meetings and finally from experience gained from work (Graph 3).



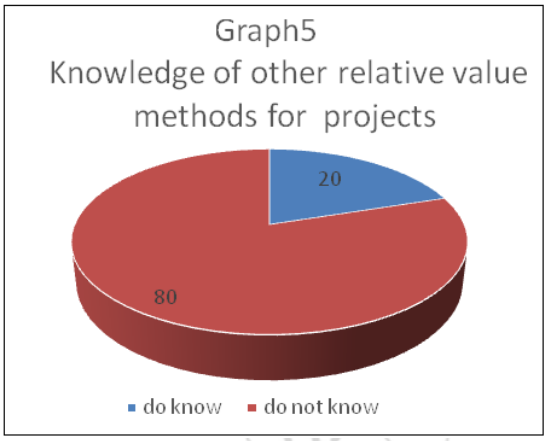
4.2Application of V.E.

In the question if there is any application of V.E. in any kind of project in the company only 23.8% of the persons asked

answered positively, whereas 76.2% of them answered negatively, as illustrated in Graph 4

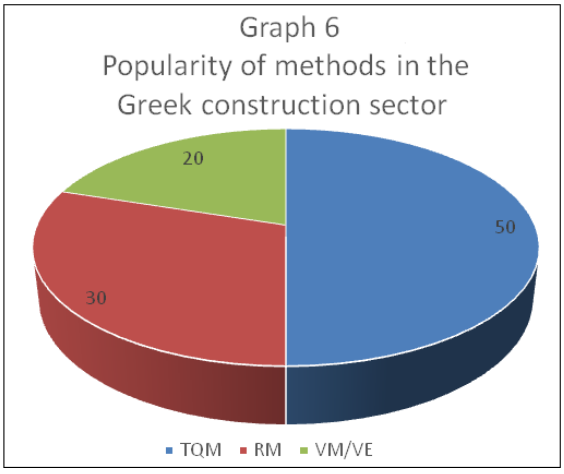


Most of the respondent do not know any other method relative to the value of a project as opposed to some that do know, for example Quality Management, Cost Benefit Analysis and Risk Management. The results are illustrated in Graph 5

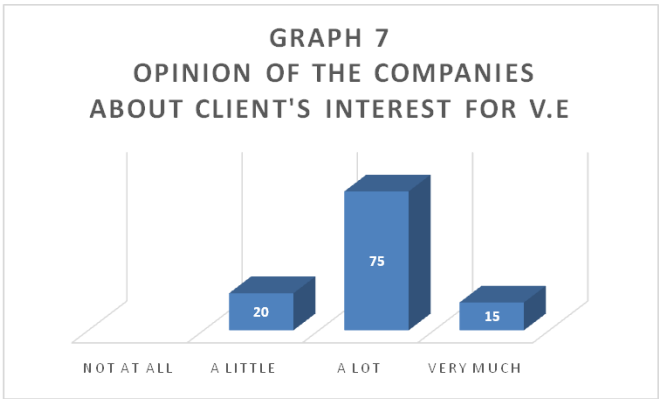


The next question compares the popularity of the methods in the construction sector between Total Quality Management (TQM), Six Sigma, Reengineering, and Risk.

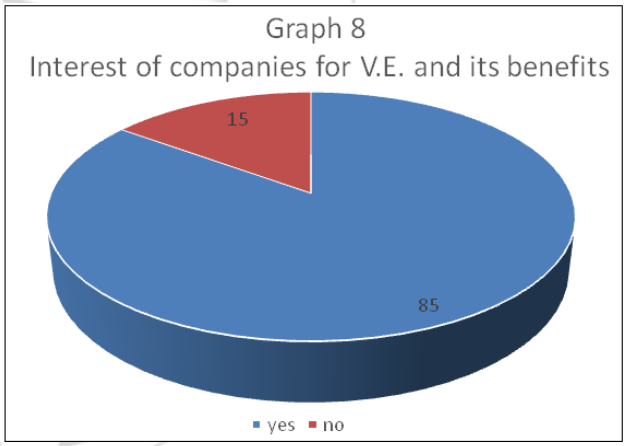
Management (RM) and V.M. / V.E. The results are illustrated in Graph 8 where TQM and V.M / V.E. seem as the two most popular



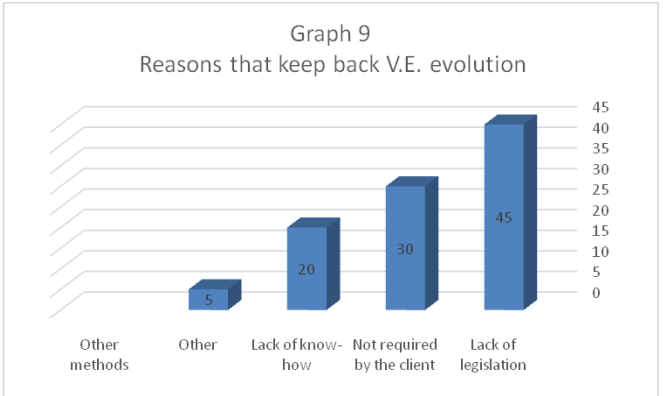
A big percentage of the sample believes their clients would be very much interested in increasing the value in a project, through V.E. methodology. However, a small percentage believes that this is not of great interest from the client's point of view (Graph 7)



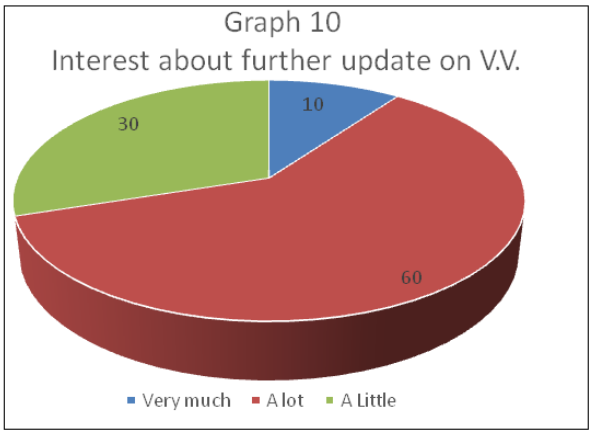
In many E.U. Countries such as the U.K. and Germany, V.M. is applied in the private as well as in the public sector, where savings vary between 6% and 20% without impact on time and quality. The sample was asked whether this may interest their enterprise, so that the company can gain these profits and become more competitive in the sector. Obviously most of them answered positively, although some negative answers did occur. (Graph 8)



The last question about the use of V.E. examined the reason why V.E. is not applied The answers were divided between: is not required by the current legislation, is not required by the client, lack of know-how and update, as illustrated in Graph 9.



n the question if there is any interest for further update on V.E. via an informal conference, most of the sample answered positively (Graph 10).



5. Conclusion

The necessity of effective the application of value engineering is generally acknowledged by the construction industry and the findings indicate that VE is recognized as an effective construction industry Management tool. Many concede that a variety of problems exist within the construction industry process which need addressing such as the amount of complex information to be communicated. The literature supports the concept that an individual designer's approach affects the design method which they employ, endorsing the idea that construction industry is a complex, creative and undefined process. Management techniques have a definite origin and a structured development. Design and management are therefore perceived to have contrasting interfaces and conflicting agendas. A set of tools to aid construction management can be identified although these differ widely in the skills required and the issues dealt with. The findings recognize VE as an effective design management gests that VE has not reached its potential in the tool. Much of the information construction industry. This lack of implementation is considered surprising especially in the light of the documented evidence of its potential benefits. The findings of the literature review indicate that VE is recognized and accepted. Within the construction industry as being beneficial to the success of a project However, findings imply that the industry is relatively inexperienced in using VE. The education of all participants in the project development process would lay the foundations for its wider adoption. However the inference can be drawn from both the literature review that the entrenched habits which exist could be moderated by a more multidisciplinary education before those joining the industry begin to work within their own professions.

The books supported the findings of the literature review that the early application of VE within a project's life increases the rewards which can be reaped from focusing on design functions and construction objectives, highlighting how the budget cost can be achieved, while maintaining quality and performance standards. The only obvious missing benefit cited by literature that the respondents did not consider was that VE could be used to benefit other similar work without completing another VE study encouraging the use of feedback and data collection.

The need for change to overcome the problems which beset the industry is much reviewed and long recognized. Over a period of time documented evidence has reiterated the benefits and barriers to the use of VE. However to date the response from the industry is slow. A holistic approach is difficult within a fragmented industry where each project is developed by a multi-disciplinary temporary organization. It can be surmised that the widespread use of VE techniques in the US was promoted by government intervention as a leading client in the construction industry. Elevating the status of VE as a design management tool by experienced and regular clients of the construction industry would support its wider implementation. The study indicated that the present culture in the UK industry is extremely time conscious. The industry concentrating on the construction phase as this activity is Observable and difficult to condense, and often choosing procurement routes which allow for the design process to parallel the construction process. Although evidence shows that it is the decision making or design process that has the greatest effect on the programming and cost of later events, the period allocated to it is often reduced. Embracing the concept of VE as part of effective construction management would aid competitiveness construction market. Therefore professionals involved in managing the design need to understand the conflicting agenda that exist between design and management and understand the tools which can aid the management of the construction process. The decisions made in the early stages of a project affect all its aspects, yet the industry spends the least on this stage, in contrast with other industries. There is a need therefore to review how the budget of a project is allocated. If this stage of a project's life is considered to be one which has the greatest impact on the outcome of a project, then the resources spent on this stage should reflect its importance. It may be that there is as yet no universal acceptance of the importance of the construction stage and without this the standard use of design management tools, such as VE, will not spread.

Our research suggests that a lack of management support is not a primary cause of the lack of use of VE as a construction management tool, which is at variance with the literature review. The difference could be explained by the perception within the industry of the extent to which senior management has the power to change the culture of the industry. The change culture of the construction industry that the respondents call for implies that senior management needs to appreciate the benefits of using V.E as a construction management tool before its implementation can be increased.

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